JOURNAL
OF THE
WASHINGTON ACADEMY OF SCIENCES

VOL. 16 FEBRUARY 4, 1926 No. 3

ENTOMOLOGY.—*Entomological taxonomy: its aims and failures.*[1]

1. FROM A TAXONOMIC VIEWPOINT. S. A. ROHWER, Bureau of Entomology

When the idea of this symposium occurred to the chairman of the Communication Committee, it is very probable that he had recently seen some paper of a "taxonomic" nature which seemed to be lacking in a number of desired features. Otherwise the symposium would probably have been given a different subtitle, for I doubt very much the propriety of the use of the word "failures." The strongest idea it was intended to convey was "shortcomings." Be that as it may, we have accepted the subject for discussion and I think it is one we may well discuss. The science of Biology has made remarkable strides in the last twenty years. It has had opened before it many lines of investigation which were heretofore unknown.

Some of these new studies have gained such popularity that their patrons have thought so well of themselves and the importance of their investigations that they have coined new "ologies" to separate themselves from the other workers. All this time taxonomy has continued and has attracted the attention of only a few. More recently, however, the pendulum has swung back and today the classifier is held in more esteem. The time seems to be passing when it will be necessary to apologize for the fact that one is a taxonomist. This returning into the good graces will not last long unless the students of taxonomy avail themselves of the materials which have been gathered by investigators in related fields, for taxonomy can not be a deaf and dumb science and still live. For this reason it seems desirable to discuss the aims of taxonomy, and as we consider these perhaps we may in our reflection see some shortcomings.

[1] Papers presented at the 373d meeting of the Entomological Society of Washington, held March 5, 1925.

Before getting too far into the subject it will be well to accept, at least for the moment, a definition of taxonomy; and while we may not all agree, I venture the following for consideration. Taxonomy consists of the grouping of organisms in a phylogenetic manner after a consideration of all of their characters and characteristics.

Accepting such a broad definition, the taxonomist must base his classification not only on external morphology but he must also call to his aid anatomy, physiology, embryology, cytology, ecology, paleontology, and distribution; in fact, he must consider his organism not by itself alone, but he must understand its function and its place in relation to other organisms past and present. To do all this is no small task, and to say that, is not all. If in entomology we were dealing with a limited number of forms and if these forms had such habits as to permit a detailed study of them, the task would be of sufficient magnitude. But when we consider that conservatively estimated there are about 640,920 described insects, and that this represents perhaps less than one-tenth of the forms which actually exist, and that for most of these 640,920 forms, we know only a few cabinet specimens of adults and nothing concerning their habits, the task becomes stupendous. It is very probable that this very fact has caused the taxonomist to become so deeply involved in the details that he has lost sight of other allied "ologies," and thus received such criticisms as "Oh! he is only a narrow taxonomist." But let us not stop with these apologies. We grant the magnitude of the task and we admit also that some very good results have apparently been obtained by a careful comparison of morphology. If good results have been accomplished by a study of parts, how much better the results will be if we consider the whole.

But let us go back and consider briefly some of the various lines of investigation a taxonomist should be familiar with and include in his consideration when making a phylogenetic grouping. I imagined I saw a shaking of the head when I suggested paleontology—I hope not. Yet most taxonomic entomologists ignore the fossils. So much are they forgotten that many times they are not cataloged. Such an attitude can not be defended by any scientific excuse. Where would be the classifications and the fundamental results derived from them in mammalogy had the fossils been thrown aside because there were too many recent things to describe?

When I used the word "anatomy" a short while ago I meant to restrict the use of the word somewhat, and had in mind more a consideration of the internal softer organs. So little is known concerning

these in insects that not much can be said, yet when more is known and their function better understood, I venture the suggestion that the taxonomist will find valuable evidence to refute or uphold his major groupings. Of embryology and cytology little can be said, yet both of these lines of investigation will furnish valuable aids to a true phylogenetic arrangement. Distribution if studied carefully will often prove of great aid. When I hear discussions of so-called discontinuous distribution, the first thought that comes to my mind is, how about the true relationships? Perhaps many of the examples of discontinuous distribution are due to faulty taxonomy. If there is anything in this thought then a study of distribution may help the taxonomist to see some of the weak points of his classification; hence it is a line of study the taxonomist should consider. And there is also the converse, for a study of distribution may just as well tend to show relationships.

In including ecology in the list of fields from which the taxonomist must expect aid, I have ventured to use a comprehensive definition of the word "ecology," and I have therefore included under this head the information usually listed by taxonomists under such headings as "host," "habitat," and "habits." Taxonomists have long paid considerable attention to the host and host plants, and to a lesser extent have they considered the habitat and habits. The consideration of these points is of importance, and when we get the phylogenetic point of view it becomes more so. We cannot logically expect that groups which have complex host relationships and specialized habits will give rise to groups with simple host relationships and generalized habits. Such may be the case. Cases of reversion are known, but a classification which indicated that this was true might well be carefully and critically examined before it is pronounced as having been made along phylogenetic lines.

We have considered only very briefly some of the points but before my time is completely gone, I want to include a word about nomenclature, the bug-bear of most taxonomists. I said "most" and I believe advisedly because there are some who have in my opinion so completely forgotten the true significance of nomenclature as to be in the position of trying to put the cart before the horse. My appreciation for the standardization of names, the application of general rules and suggestions on procedure is very great. In fact I fully appreciate nomenclature, so much so that I have been guilty of doing nomenclatorial things. But I have not as yet forgotten, and I trust I never shall forget, that nomenclature, as we entomologists use the word, is only a

handmaid to zoology. Nomenclature deals with names, not animals. I venture the guess that less than ten per cent of the changes in the names of insects are due to nomenclature. Most of them are due to a change in the conceptions of groups. In other words, they are made for zoological reasons. It must be so. The classification of insects must change. New facts are before us every day. We apply these in our taxonomic work and we change the name of some little insect or other. Such a change is not due to nomenclature. But I have almost forgotten why I brought up this handmaid to taxonomy. No taxonomist likes to change names but no taxonomic work, however sound from a phylogenetic point of view, can stand for a long period of usefulness unless its author carefully considers the nomenclature of the group. It is essential that entomologists agree on names, and if all taxonomic workers hasten to establish the landmarks by which group names may be recognized, fewer changes will be necessary and their work will be of a more permanent nature. The establishment of genotypes for all genera and especially those on which supergeneric names are founded is important, and to a very large extent this must be done by the taxonomist.

In our definition we said taxonomy was the grouping of organisms and this presupposes there are organisms to be grouped. So a study of taxonomy must first await the accumulation of materials. A taxonomist without a collection is as bad off as the man at sea without water and the one with a small collection is perhaps, as far as real progress is concerned, worse off. If proper taxonomic work can be done only when all factors are considered then to work in a taxonomic way over only an incomplete assemblage of specimens can not produce good results. In almost every group in insects we have examples of poorly constructed classifications because of an examination of an inadequate number of specimens. We must not discourage the collecting instinct in the taxonomist. On the other hand we should lend him all encouragement. We should place at his disposal for study all the material of his group. He should have material from all regions and in sufficient abundance for him to study the variation of individuals.

This need for collections imposes an obligation on the taxonomist as well as those who foster his work. It makes it necessary for him to care for these collections; they must be arranged in a careful, orderly manner; they must be labelled. The taxonomist must leave to his science and posterity evidence from which he made his conclusions. There must be no doubt about the fact that certain specimens were seen. The taxonomist has therefore devised a method by which his

co-workers and successors can know what he was talking about. He calls certain specimens types. But this is not enough; he forms conceptions about other workers' groups and he must leave evidences of the limits of his conception. Here many workers are negligent. They do not tell us definitely about these. The aim of all taxonomists should be to leave the evidences of their work in such good order as to leave no doubt in the minds of other workers on what their conclusions were founded. In short the taxonomist should care for his collections and arrange and label them so as to aid, not hinder, other investigators. I am sure all of you could cite many shortcomings here.

Another aim of taxonomists is large libraries. The taxonomist must know what others have done. In a field as vast as entomology this is of the greatest importance. It is impossible for one worker to know all. It is imperative that he know what has been done before. Large libraries must also be considered a necessary aid to taxonomic work. But libraries are of but little use unless one knows what is in them and where to find it, so indices are necessary. In view of the rapidity with which work is being published, these indices must be up to date to be of real service. While in a certain sense one can hardly say these libraries and indices are aims to taxonomic entomology, we must admit they are aims of taxonomic entomologists, and you all will agree it would fill a large volume to list the shortcomings because of their lack.

Summing up briefly, the aim of taxonomic entomology should be the phylogenetic classification of insects based on all available evidence, such evidence to include a consideration of anatomy, morphology, embryology, cytology, physiology, paleontology, ecology and distribution. If such are the aims of taxonomy then we have only to examine our literature to see how completely we have met them. Such a consideration of the literature would probably make many feel that there had been many shortcomings. Of course there have. But many of them are due to the magnitude of the task and some of them are due to the changing viewpoint.

I hope the viewpoint may continue to change, that taxonomists will continue to include in their papers more and more information concerning all the characters and characteristics of the insects they treat. Many taxonomists have much of this information at their command and use it consciously or unconsciously in forming their classifications. Let us urge them to include more of it in their papers so they may be storehouses of information to other workers. By doing so their usefulness will greatly increase and they will rise in the esteem of workers in allied fields.

2. From an Economic Viewpoint. A. C. Baker, Bureau of Entomology

I have been asked to discuss the relation of taxonomic entomology to economic entomology and the failures of the former in this relationship. Such a request in itself indicates the failure I shall mention. Perhaps, however, it is not a failure. Perhaps it is merely a circumstance incident to growth.

Lest I be misunderstood I wish to distinguish clearly between the science of insect life and those practices in the art of agriculture which concern themselves with insects and with which entomologists as agricultural advisors have much to do. This dual function of the entomologist, as advisor and as discoverer, has confused certain practices of the art with the science that underlies them. I presume that I am not expected to discuss the relation of taxonomic entomology to the art of agriculture.

Since this symposium is on taxonomy it may be well at the outset to delimit the different fields that are often confused with taxonomy by reason of the fact that taxonomists work in them. We must distinguish taxonomy, classification, and nomenclature. Taxonomy, as its name implies, is not concerned with the arrangement as such but with the reasons and causes back of that arrangement, with the underlying principles. Classification, on the other hand, constitutes the arrangement itself. Thus the same taxonomy may be employed in a classification of a family of Hemiptera or in that of a family of Hymenoptera. Nomenclature, again, is a subject which is concerned with the correct names for the units in a classification. It deals neither with the methods back of the classification nor with the classification itself. Thus we have nomenclature as a result of classification and classification as a result of taxonomy. In this relationship taxonomy is basic.

As I see it, there are three types of taxonomic entomology today, and these three types recapitulate the three stages in its growth.

The first is the accumulative type. Here the main interest centers on the collection. The aim is to complete the series, to amass material. Species are described. These are carefully placed away, perhaps according to some accepted classification, and other species are described. Of this type I shall have little to say for the reason that it concerns itself very little with taxonomy as I understand it. In many cases even the classification is already a fixed conception. The author merely adds to the nomenclature of that classification in the naming

of species not already included. In regard to this type, however, I shall say one thing. It might be of enormous advantage. As it stands today its devotees are interested in individual groups. They pick these from the population and ignore the others. But in a study of the accumulative type the interest should lie in the equilibrium of the population. It is better to know the workings of a field than the disconnected items of a world.

The second type is the morphological one. Here the main interest centers on structure. Dissection is not uncommon and an attempt is made to reconstruct the relationships by means of the structures studied. Phylogenetic trees therefore are the mode and theoretical discussions are common. There may even develop a voluminous literature on the interpretation that should be placed on the veins of the wings or the spines of the legs. Most taxonomic entomology today is of this type. Perhaps it is so of necessity. While I realize the valuable contributions that have been made from this viewpoint and the great handicaps under which brilliant men have labored in this field, I can not help feeling that this type of taxonomy has one decided fault. The structure is the primary concept and in concentration upon it the entomologist is apt to lose sight of his real goal. The broader visioned taxonomists of the morphological school, however, are alive to this danger. Hence they constantly discuss and write about the suitability of characters. They talk of natural characters and of artificial characters, but they do not tell us how one character can be more natural or more artificial than another.

The third type is the biotic one. Here the main interest centers on the insect alive rather than on its dead body. The taxonomic laboratory is no longer an orderly array of dead insects. It is a dynamic world of living things. In its fullest realization this type requires some departure from the usually accepted ideas. Side by side with the collection will be, not only the morphological laboratory, but the insectary where the insects may be studied alive. And beyond all this there will be the outdoors. The taxonomist will once again become the naturalist, but with this difference he will have at his command a great store of modern technical methods.

The biotic type of taxonomy will not only change the work, the publications too will change. They will be appreciated. A monograph of a genus will no longer lie uncut upon the shelf. It will become a live book full of interest for the biologist, the agriculturist and the physician. It will be used and its author will receive the credit he deserves.

TABLE 1.—Classification of Subfamily Eriosomatinae

Forming galls or pseudo-galls on trees and migrating to trees or herbs, usually to the roots

GENUS	PRIMARY PHASE	SECONDARY PHASE
Elm Association—Tribe Eriosomatini		
Eriosoma	Elm galls or pseudo-galls	Roots of woody plants
Colopha	Elm galls	Roots of grasses
Georgia	Elm galls	?
Tetraneura	Elm galls	Roots of grasses
Dryopeia	Elm galls	Roots of grasses
Gobiashia	Elm galls	?
Poplar Association—Tribe Pemphigini		
Pemphigus	Poplar galls	Roots of herbs
Cornaphis	Poplar galls	?
Mordwilkoja	Poplar galls	?
Pachypappella	Poplar galls	?
Pachypappa	Poplar galls	?
Asiphum	Poplar pseudo-galls	?
Thecabius	Poplar galls	Herbs
Gootiella	Poplar galls	?
Pistacia Association—Tribe Fordini		
Forda	Galls on Pistacia	Roots and nests of ants
Aploneura	Galls on Pistacia	?
Pemphigella	Galls on Pistacia	Roots and nests of ants
Paracletus	Galls on Pistacia	Nests of ants
Geoica	?	Roots attended by ants
Tullgrenia	?	Roots attended by ants
Trifidaphis	?	Roots attended by ants
Damp woods Association—Tribe Prociphilini		
Neoprociphilus	Maple	Smilax
Patchiella	Tilia, Ash	?
Prociphilus	Ash	Roots of plants
	Maple	Alder stems
	Amelanchier	
	Crataegus	
	Lonicera	
Rhus Association—Tribe Melaphini		
Melaphis	Galls on Rhus	Roots of moss
Nurudea	Galls on Rhus	?

Most work today is associated with the evolutionary viewpoint. As taxonomists, however, we have conceived of morphologic evolution. We have concentrated upon supposed species. But if there is an evolution it is the entire environmental complex that evolves. Things change only in relation to other things. Perhaps I can make myself clear by saying that taxonomy should concern itself with events more, with supposed things less, with the quantitative record of conditions all the time. Our enthronement of type specimens is an admission of the failure of our taxonomic method.

I may be pardoned if I refer to the group on which I have worked the most, the aphids. My excuse is that I know this group the best. Five years ago I presented a classification of this family. That classification was woefully inadequate. In order to illustrate the taxonomy employed, however, I am showing a tabulation of one subfamily, the Eriosomatinae (Table 1). It will be noted that an attempt was first made to determine something of the living insects. Host relation was selected by reason of the fact that the insects are peculiarly phytophagus. The selection thus of one factor is admittedly weak. For as it is, the total association evolves so that it is the assemblage of factors that must picture the events. One factor however appears at times to be almost a master one and to reflect the others. On this possibility we have chosen host relation in this subfamily. The primary phase of the life cycle was accepted as fundamental for reasons that are obvious.

It will be noted that certain associations at once become evident, such as the Elm Association, the Poplar Association, and the Pistacia Association. The insects falling in these associations were again segregated, using type species and the habits of type species as a basis. The list of genera falling in the Elm Association reveals certain morphological characters common to all species and peculiar to the genera in this Association. These characters therefore distinguish the tribe. A similar examination of the forms in the Poplar Association shows other characters peculiar to these genera and common to them. The correct diagnosis of the tribe Pemphigini therefore becomes evident. And so the examination proceeds throughout all of the associations. In the end we have tribal descriptions which reflect not only structures common to the insects falling therein, but life habits which are equally common to them—a classification of the animals alive.

It will be urged by some that taxonomic studies of this kind deal altogether with secondary things, that structure is basic. But if we

accept evolution surely it is activity that is basic. Unrelated forms may of course show similar habits but such forms would segregate earlier on other biotic factors.

But aside from this question the economic value of the taxonomy employed will be clear if we look for a moment at the Tribe Fordini. Species of the genus *Forda* are common in this country on the roots of plants and in ants' nests. Considerable study has been given to the species, and occasional revisions or partial revisions have been published. But these revisions left us in much the same state as we were before, for the reason that the investigators worked from the morphological viewpoint. More supposed species were described, but this only meant, at bottom, a more complete catalogue of our ignorance, for the work was all done on the incomplete secondary phases of the life cycles. The workers did not conceive of the Pistacia Association. Had they done so they would have realized that the key to the genus on this continent lay only in Texas and southward, and that years might be spent on the secondary northern remnants of these Pistacia forms without any real advance in knowledge.

A similar picture of this very kind is the history of the study of the woolly apple aphis, *Erisoma lanigerum*. For a hundred years men tried to solve the life history of this economic insect. Medals and prizes were offered for its solution. Years of research and large sums of money were spent without result.

A glance at the biotic arrangement on the screen will show how simple the solution becomes; and it is equally simple in other instances. When we find another species of *Eriosoma* as a pest on pear roots we turn at once to the elms. When we find still another very injurious to the roots of gooseberries we turn once more to the elms. Still another species is abundant on the roots of service berry and once again we take our way to the elms.

Another example may be given. When a *Pemphigus* is discovered as a pest of the beet fields we can turn at once to the poplars for its complete cycle. In another region the poplar segregated does not exist but the beets are nevertheless attacked. So we find a different poplar with a different *Pemphigus* migrating to the beets as before. Still another species is a pest of crucifers, and turning to the poplars we can determine its identity and the economic factors involved.

Time will not permit me to follow the argument further, but I shall give one word in regard to the reception this work has had. My paper in 1920 did not give completely my taxonomy. For obvious

reasons I contented myself with a classification—with tabulating and discussing the characters resulting from the taxonomic study. Nevertheless a thorough student might discover the method in the background. Such a student is Professor Albert Tullgren of Sweden. In 1925 he referred to my classification in the following words:

"One of the most important and in parts most interesting systematic work on aphids that has been published in the last ten years is A. C. Baker's Generic Classification of the Hemipterous family Aphididae. Baker presents, often in a very alluring manner an entirely new system for the Aphididae and bases it on reasoning which often has a very convincing effect. He divides the entire family into 4 sub-families, Aphidinae, Mindarinae, Eriosomatinae and Hormaphidinae which are among themselves almost equal although the Aphidinae and the other three subfamilies are derived from two different origins of the hypothetical stem. The reasons given for this separation into 4 subfamilies do not appear to me, however, to be entirely free of criticism and I deem it therefore more cautious for the present to consider the three last groups as one subfamily."

And again he says:

"Baker divided his subfamily Eriosomatinae into five different groups, Eriosomatini, Pemphigini, Malaphini, Prociphilini and Fordini. If one studies closely the characteristics of differentiation one finds that he derived the same first of all from the biological differences of the generic elements. And one can not help thinking that he put a higher value on these characteristics than on the morphological ones. For this reason presumably he has arrived at the peculiar conclusion, according to my opinion, that the Pemphigini and the Prociphilini represent two different branches of the stem which are about equal to the Eriosomatini."

I have cited Tullgren because I know him to be a scholar. Perhaps he is right. I forsee the day, however, when the taxonomist will not be set apart from the economic entomologist, when the collector will concentrate on true samples of the population, when the morphologist will consider function as important as form, and when all life history studies will be made by taxonomists of the biotic school. When that day comes there will be only one type of entomology. It will be economic. Its aim will be to understand and to express with mathematical exactness the laws and principles underlying the elements, the contacts and the inter-relations of the insect world. We are fast approaching the saturation point of our population and the day may not be far distant when we shall be pressed for that understanding.

3. From an Educational Viewpoint. E. D. Ball, Department of Agriculture

Taxonomy in its highest development, as I conceive it, is an explanation of the actual relationship of existing forms of life to each other. Although of necessity expressed in a linear series it should be an arrangement of the existing branches of the tree of life into groups according to their derivation and into a series showing inter-relationship of the groups. In the major branches of both botany and zoology, taxonomy has already approached this idea. When it comes to the lesser divisions and more obscure relationships it is still far from certain of its foundations and is undergoing a gradual evolution as new discoveries in fossil forms are made and new interpretations of relationships in living species are established. Taxonomy, then, in its ideals is an interpretation of evolution, one of the most profoundly interesting and profitable fields of biological research.

Taxonomy in its lowest expression is merely an enumeration of a group of individuals. Enumerating individuals for taxing purposes was man's earliest effort and from this the science received its name. Some taxonomy has not materially advanced above this level. Let us illustrate: It would be possible to classify an indefinite number of wooden blocks of different shapes so that each one of a given group would fall into a definite category. The primary division might easily be (A) long blocks; (AA) short blocks; and (B and BB) under each one might be blocks with right angles and blocks without right angles, and so on indefinitely, and when you finished your task you would have a classification for taxing purposes only. It certainly would not be of value for any other purpose. You could take a saw and in a few minutes change a given block so that it would go into an entirely different classification. Your classification was therefore entirely artificial and empirical. On the other hand, you *might* have classified your blocks into hard woods and soft woods. You might have gone further and classified your soft woods with reference to certain structures which would have separated the coniferous from the deciduous forms, and continued this segregation to a completion of the group. Such a classification could not be altered by any use of a saw. The block of wood would fall into its correct classification regardless of what was done to it. In other words, it would have been a classification rather than an enumeration. In many of our taxonomic efforts, especially where working with a very small representation of a group or with little knowledge of ancestral forms, our classifications may be very

little better than the long and short sticks of wood, but if we attempt to make a rational classification and follow it as far as our knowledge at the moment permits, correcting it from time to time as our knowledge increases, we are doing the best we can and following the path of the evolution of all knowledge.

There existed for a long period a large school of morphologists who openly ignored and belittled taxonomy. Happily that day is passing. I remember working in a laboratory for a year with an earnest and conscientious young man who was working industriously tracing the development of the lateral line and its sense organs in an embryo of a salamander. I was at the same time working on the evolution (taxonomy if you please) of a certain group of leafhoppers and we used to have frequent arguments as to the value of taxonomy, a value he did not at that time recognize. When, however, he had his work completed and was preparing it for publication he suddenly discovered that there were other genera of salamanders and that the references which he had been consulting were all about a certain common species. Not knowing that there were other genera he had failed to look up these references until his work was completed, and then he found a large volume of morphological work which indicated that there were wide variations in the embryonic development of the three groups, and the poor fellow did not know to which group his original salamander belonged. That was a quarter of a century ago and as far as I am aware he has never been able to name his salamander or publish his results.

Most of you are familiar with the classical case of the entomologist who worked on the spermatogenesis of a certain species of insect or thought he did. He had the species in the wrong genus, worked up the wrong literature, found that it did not agree with the determinations made by European workers, wrote a strong criticism of their work only to have his material re-investigated and the discovery made that he had been wrong in his taxonomy and wrong in his morphology. Although not belonging to the genus, it *did* agree in the morphological changes.

There have been taxonomists who were equally indifferent to the biological and morphological relations of their work. All insects with long spines were placed in the group as against those with short spines. All dark insects were segregated from the light ones, entirely ignoring the fact that the length of spines or the color might easily be adaptations to certain food plants or environment and have occurred independently in groups of widely separated ancestry.

Evolution does not take place in structure alone or in function alone. Variations in animals take place in all lines, in structure, in function, in habit. It is only when we consider all of the factors in their relation to each other that we arrive at a true concept of the path of evolution.

The teaching of economic entomology has departed widely from that of the related sciences. The major portion of our textbooks has dealt with apple insects, corn insects, cotton insects, and the like. The student has a large amount of miscellaneous information of detailed life history and remedial measures centered around a certain crop plant and its environment. Instead he should obtain a thorough understanding of the fundamentals of insect biology so that if he meets a new pest he can apply his fundamental knowledge, and in a majority of cases have a fairly definite idea of the methods to use in control. Instead of getting the details of the 17-year locust in connection with the apple he may well learn that the *Cicadidae* as a group spend a long larval period in the earth, that their resemblance to an army tank is not accidental but an adaptation to that environment. He can then learn that the wireworms as a group also have a long larval period, that in general they have a definite relationship to weed growth or known cultivated crops, and even when he meets an exception to this general rule it will be noted as an exception only to emphasize the fundamental importance of the general adaptation. On the other hand, when he is studying the leaf-feeding forms he will readily realize that short larval periods are absolutely essential to the preservation of the species and will marvel at the many modifications which nature has worked out to adapt insects to the particular favorable period for this larval appearance. Such a course in entomology will train him to think and arouse his interest and enthusiasm, while the other course will be largely a training in memory and the mastery of definite details rather than the working out of principles and the development of theories.

In conclusion I would say that every entomologist should study taxonomy. In fact I would go further—that every entomologist should be a taxonomist in some group, large or small. If every economic worker would carry the responsibility for working out some small unit of our classification he would find it a wonderful stimulus to further development, as well as a broadening influence that would give him a wider series of contacts which would be of value. The aggregate of such small contributions would rapidly advance our knowledge of many little known groups, and if he selected his own economic group

for consideration it might easily change his whole viewpoint of the economic relations.

In the same way I believe every taxonomist should be deeply interested in and a student of the biology of his group, that as far as possible he should work with living material, and that in every case at least one or more species should be studied in large numbers, and thus develop the normal range of variation and adaptation within the species. In this way the systematist would be much clearer in his concept of what constitutes a species and be much more sympathetic with those who are struggling with biologic forms. In a number of fields it is becoming impossible to ignore the fact that there exist definite and fixed biologic forms which we can not, as yet at least, recognize by ordinary taxonomic characters.

Taxonomy as a whole has already reached a position where many divergent lines of proof can be brought to bear, all of which indicates that our major conclusions with reference to the evolution of our groups are accurate. A study of the parasites of the higher animals, for instance, shows a parallel development with that of the hosts. It shows that the parasites have differentiated as the hosts have differentiated. There are internal parasites and external ones; each one of these can be subdivided into different groups, and when the same evolutionary detail can be worked out for all of the groups each one will tend to confirm the accuracy and authenticity of the others. The writer was much interested a few years ago in checking up with Dr. W. D. Pierce on the classification of the Stylops in relation to the classification of the Jassidae and Fulgoridae that they parasitized. The Jassidae as a group are primitive with a certain number of specialized lines. The Fulgoridae as a group are highly specialized with only a few primitive lines. Dr. Pierce's classification of the Stylops indicated that the same relationship held with reference to the parasites. When taxonomy is approached from this standpoint it becomes one of the most valuable forms of biological study and can be recommended as part of the training of every entomologist and a part of the life work of a much larger number than at present.